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NATIONAL BUREAU OF STANDARDS REPORT

NBS PROJECT **NBS REPORT**

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PROGRESS REPORT ON ENGINE AIR CLEANERS

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to

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Department of the Army

NBS

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

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PROGRESS REPORT ON ENGINE AIR CLEANERS

A thorough investigation of the publications pertaining to the wear of combustion engines due to dust in the intake air showed that dust particles of 10 to 25 microns size caused the most damage per unit weight.

It appears probable that a large percentage of the smaller dust particles, comprising only a small portion of the total weight of the dust, may pass the conventional air cleaners and cause excessive wear of helicopter engines. This consideration indicated the necessity to investigate not only the overall efficiency of the air cleaners but the several separate efficiencies in various dust size ranges.

Table 1 is a summary of the reports of 19 engine air cleaner tests made at the Detroit Arsenal and received through ASTIA. Of these 19 cleaners only 4 passed the acceptance specifications, and all but 4 did pass the required efficiency test. All other filters failed to meet either the capacity or the restriction requirements. One air cleaner, Code A.8, was found to have such a high restriction to air flow that no further tests were made of this specimen. The efficiencies varied from 95.4% to 99.21%, 97% was the minimum efficiency required for these tests, and it is felt that a better differentiation is desirable than the ± 2% total variation reported on all the various models.

Table 1

Summary of 19 U. S. Army Tests on Engine Air Cleaners

Filter	Dust Efficiency, %	Test Results			Remarks
		Capacity	Restriction	Acceptance	
UM - 185	98.2	ok	ok	accepted	
Code A-1	99.0	no	no	no	
"	99.21	no	no	no	
1618 A-3	97.9	ok	ok	accepted	
Code A-5	95.4*	no	no	no	
" A-6	97.9	ok	ok	accepted	
" A-8	-	-	no	no	Due to very high restriction, no further tests were made
" A-10	97.45	ok	ok	-	Experimental model
Experimental model	95.7*	-	-	-	
Code A-24	98.49	no	ok	no	
" A-29	96.91*	ok	no	no	
" A-31	97.82	no	ok	no	
" A-32	97.37	ok	ok	accepted	
" A-33	98.96	no	ok	no	
" A-34	96.84*	no	ok	no	
" A-36	97.0	no	no	no	
" A-42	98.2	no	no	no	
" A-54	98.3	no	yes	no	

* did not meet requirements

The determination of the efficiency in these tests was based on the assumption that all dust passing the filter was retained in a flannel cloth installed downstream and that the weight increase of this cloth, dried before and after the test, would represent the weight of the escaped dust. Though the evaluation of this method is very simple it has two setbacks:

1. It appears questionable that the flannel cloth will retain a high percentage of small dust particles. The high efficiency of oil-impingement type cleaners for large size particles appears common. Therefore, if the so-called absolute filter passes a good portion of the small particles, then the weight retained there is no longer indicative for the amount of dust that passed through the cleaner.

2. The handling and weighing of the filter cloth of up to 30 inches diameter may cause the loss of a certain amount of dust which also tends to distort the test results.

Proposed Efficiency Test Method

Based on these reservations it is proposed that three different and independent methods shall be used to determine the air cleaner efficiency. These methods may be modified, later, as experience is gained, and one or the other may be completely deleted.

1. The overall efficiency will be determined by drawing under isokinetic conditions a small flow of air from downstream the cleaner through 0.3 micron glass fibre paper, which retains all particles above the size of the fibre.

2. The dust will be classified in four size ranges by use of a Cascade Impactor. By sampling the air upstream and downstream the filter the number of dust particles of each of four size ranges can be determined for a known volume of air, by counting.

3. The Hill-Trion dust spot tester shall be used to determine the difference of the dust concentration upstream and downstream the filter by means of the discoloration method.

When using dust of the same density the gravimetrically determined efficiency will be related to the cubes of the diameters of the dust particles whereas the discoloration method refers to the square of the dust particles. It is planned to obtain correlation of these two methods by means of dust count from the Cascade Impactor.

The test apparatus being set up is designed to test air cleaners for engines as small as 50 H. P. up to the R-1830 with 1200 H. P. and to handle a pressure drop across the air cleaner of up to 24 in W. G.

The dust feed was designed to supply dust at a constant rate from 20 mg to 35 mg per cu. ft. of air at any desired air flow rate. The use of three different dusts for the first series of tests is contemplated, namely A. C. Sparkplug Co. Dusts "coarse" and "fine" and Cottrell precipitate.

All required test equipment has been ordered and the calibration of the apparatus is about to be commenced. Provided all testing equipment will be on hand as scheduled preliminary tests can be started early in August.

At present, tests are being conducted on a newly designed rotating filter. A pilot model of this filter showed efficiencies in excess of 90% when using the very fine Cottrell dust. This filter is designed as a pre-filter for oil-bath cleaners and is expected to be superior to cyclon type filter in both efficiency and flow resistance.

An early conference with representatives of the Office of the Chief of Transportation, U. S. Army, will be welcome to determine the values desirable for flow resistance, dust holding capacity, physical size of the air cleaner, etc.